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PREVENTION OF FAILURE TO GIVE A GUARANTEE CONSTRUCTION OF BORED PILES FOUNDATION AT LEMAH IRENG BRIGDE, SEMARANG – SOLO TOLL ROAD, INDONESIA

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ABSTRACT

Lemah Ireng Bridge, section VI, Semarang – Solo toll road is a monumental structure for PT. Trans Marga Jateng Tbk., Publics Work Departement, Province of Central Java, Indonesia. The bridge has span of : 85 m – 130 m – 85 m and 25 m width, more than 35 m height above the land surface. The upper structure of the bridge is box girder and the sub-structure is bored piles foundation. The bridge consists of two piers (P-1 and P-2) and two abutments (Abut-1 and Abut-2). The Construction staging of Lemah Ireng bridge is a balanced cantilever method. The pier P-1 is located on valey with a slope steep and the foundation structure laids on the clay shale, so to ensure the structure stabilities needs geotechnical studies. This paper presents the historical case failure of the slope above the Pier P-1, results of Inclinometer measurement and analysis of slope stability uses Plaxis version 8.50.

KEYWORDS: Lemah Ireng Bridge, Clay shale, Slope Failure, Inclinometer, Slope Stability

INTRODUCTION

Toll road construction is verry important activity to provide a good transportation public and to solve the traffics jam in the national road from Semarang to Solo and the traffic jam in the national road relies the surrounding cities in the Central Java province. Toll road Semarang – Solo is constructed in two phases. Phase I is Semarang - Bawen section and the second phase is Bawen - Solo section.

The main road alinnement passes at the villages, hilleys, forresters and agricultures areas. Based on the topography, the bridge should be bulit along from station 22+125 to station 22+840, that is Lemah Ireng bridge. The structure of the bridge consists of two piers (Piers P1 and P2) and two abutments (Abutment A1 and A2). The Lemah Ireng Bridge has tree spans of 85 m – 130 m – 85 m and 25 m witdh. The upper structure of the bridge is box girder and the sub structure is bored piles foundation. The Construction staging of Lemah Ireng bridge is a balanced cantilever method. (see Figure 1)

Lemah Ireng bridge has a span 300 meters length and high from ground level more than 30 meters is a monumental project for PT. Trans Marga Jateng Tbk., Publics Work Department, Province of Central Java. That's because the amount of building bridges, in this project new and high technology used and the amount of the cost allocated, so that development requires expertise, supervision measured and well planned in order to get the maximum out according to plan.

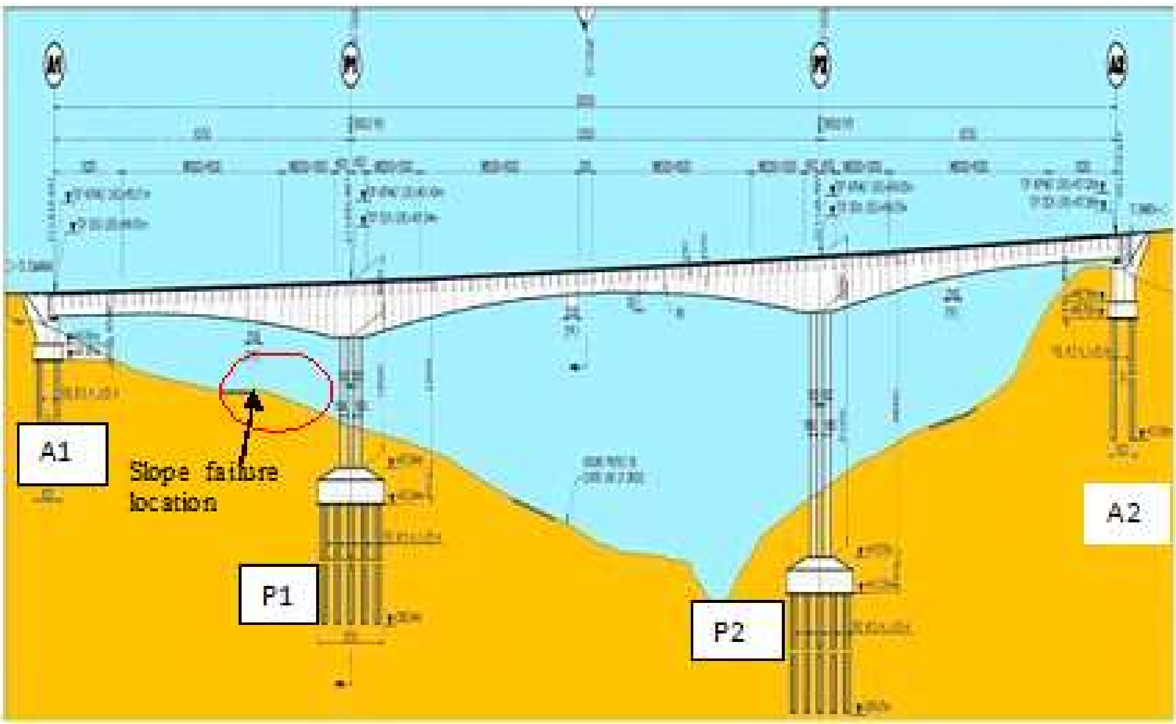
Lemah Ireng bridge stands up on clay-shale. Clay-shale is a type of ground rock hard if not disturbed, but otherwise the clay-shale when peeled, ground clay-shale contact with water and exposed to sunlight, the soil properties of clay-shale will change. Physically clay-shale changes into mud and soil strength decreased significantly.

The slip failure occurred on the natural slope above Pier P-1 when the plat-form of Pier P-1 was constructed. This failure caused by rain-fall infiltre enter the clay shale and it cause decline the shear strength of soil and be side that, the soil work was realised in rain season,

Slope collapse occurred is located on top of Pier P-1 includes a fairly wide area and a large land mass, so that it feared would disturb the implementation of the foundation work and influance the bored pile foundation stability Pier P-1 that lies beneath (see Figure 2)

Based on the situation and the condition in the field, the designer gave instruction to instale Inclinometer instrument to mesure the soil mouvement. A new slope should be built in this place to prevent the landslide and ensuit this structure to give a guarantee construction of bored piles foundation. he success of foundation construction on clay shale relies on proper planning, design, construction control and site supervision. The construction methods employed at site also have significant effect to ensure the successfully.

This paper presents the historical case failure of the slope above the Pier P-1, results of Inclinometer measurement and analysis of slope stability with Paxis version 8.50.



Fiigure 1: Structure of Lemah Ireng Bridge Sta. 22+625

Figure 2: Slope Failure Lacated at Above Pier P-1 Sta. 22+625

METHODOLOGY

General parameter of bridge: the structural concrete for all members of the bridges shall comply with the following : Ec = 33234 Mpa, Deck = f'c= 40 Mpa., Pilecap and Abutment = f'c= 35 Mpa, Pile = f'c=30 MPA and Strength at jacking = f'c= 35Mpa. Where f'c is the specifiied compressive strength of concrete at 28 days. Pier P-1 structure of Lemah Ireng bridge supports the maximum bridge load because this structure located at the longest bridge span. This structure laids on the steep valey with the natural slope steep and stands up on clay-shale.

Slope collapse occurred on the slopes located on the top position Pier P-1 stand . The collapse occurred at the time of preparation work plat form for Pier P-1 Sta . 22 + 625 is in progress and the work takes place in the rainy season. To assess more comprehensively on the slope collapse then the first step to do is to do a soil investigation at the site of the collapse.

Soil investigation has realized specially at slope failure location and around Pier P-1 Sta 22 + 625. The objective is to get a information about soil layers, condition and characteristics of subsoil, soil type and water level. The Figure 3 shows a schematic profile of sub-soil and Table 1 presents the result of laboratory tests of the soil properties.

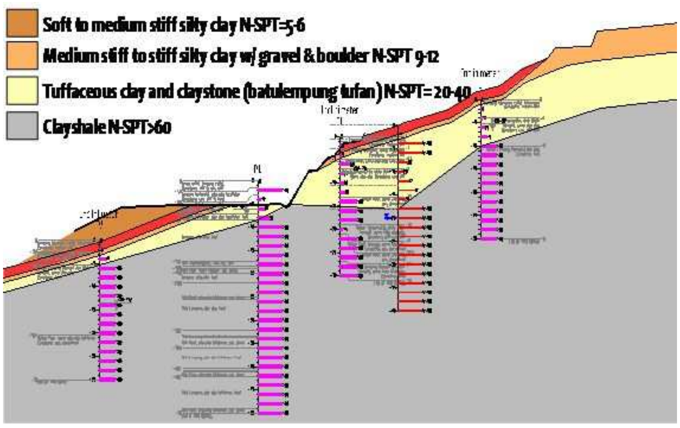


Figure 3: Subsoil Profile of the Site

Table 1: Properties of the Clay-Shale

No.	Clayshale	w Natural (%)	w Saturated (%)	GS	Compressive Strength (kg/cm2)	Cohesion (kg/cm2)	Friction Angle (°)	Composition	
								Ca (%)	Na (%)
1.	Tuffa	32,70	100	2,67	-	6,40	22	-	-
2.	Grey and weathering	9,79	125,21	2,82	45,234	11,28	37,01	0,88	0,70
3.	Dark and fresh	11,69	61,96	2,91	73,754	17,83	38,40	3,94	0,74

Source: PT. Selimut Bumi Adhi Cipta, 2012

The auther side, the condition in the field indicate that the ground moves downwards make a slit width of 1.00 meters along the northern slope. A sliding slope forms a gap and is accompanied by get out water significantly from the gap. It indicates that the landslide which occurred caused by a rain water infiltrates into the ground and caused by a soil cutting on the foot of the slope. The sliding slope include a fairly wide area and the movement of soil is predicted will push the bored pile Pier P-1.

It will disturbs the smooth implementation of bored pile foundation work and raises fears would destabilize the individual bored pile foundation before the time of execution of bored pile foundation united by a pile cap. Before the bored pile foundation work carried out then this slope sliding problems should be studied comprehensively and find the best solution first. The landslide covers a large area avalanche and to know more details of the landslide installed several pieces of apparatus Inclinometer around the area until the establishment of the location of Pier P-1 Lemah Ireng bridge. We predict this event disturbs the bored piles construction and the stability of the single bored pile, so it should be looked for a good solution before the bored piles are constructed. To find out how much area that suffered catastrophic landslide and will endanger the foundations, in the field needs some tools Inclinometer installed around the landslide area until the location of Pier P-1. Be expected with this recording and monitoring will be knowed the area of landslide and looked for the good method to solve the problems occurs. The next will provide a guarantee of the stability of the foundation structure at Pier P-1 .

INCLINOMETER MEASUREMENT

An Inclinometer or Clinometer is an instrument for measuring angles of slope (or tilt), elevation or depression of an object with respect to gravity. Inclinometer measure both inclines (positive slopes, as seen by an observer looking upwards) and declines (negative slopes, as seen by an observer looking downward) using three different units of measure : degrees, percent and topo.

To indiquate a movement of soil in around of the slope location and location of the Pier-P1 structure, was installed several inclinometers to measure the landslide or soil lateral mouvement. The observation with the inclinometers take time more than 30 days and 25 m depth from the surface land existing. Layout of the Inclinometers is presented in Figure 3 below.

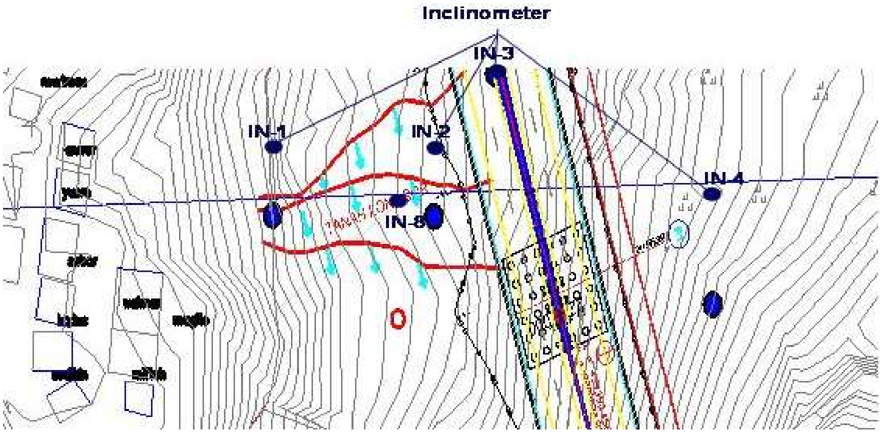
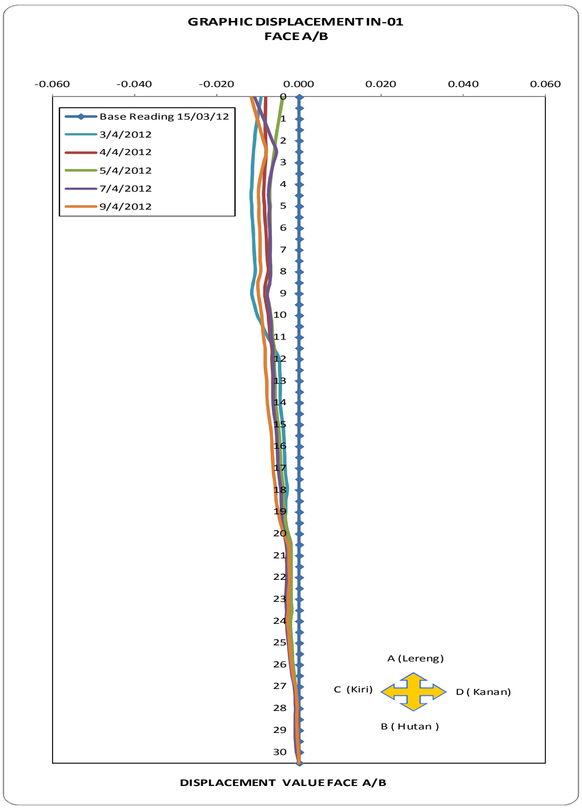
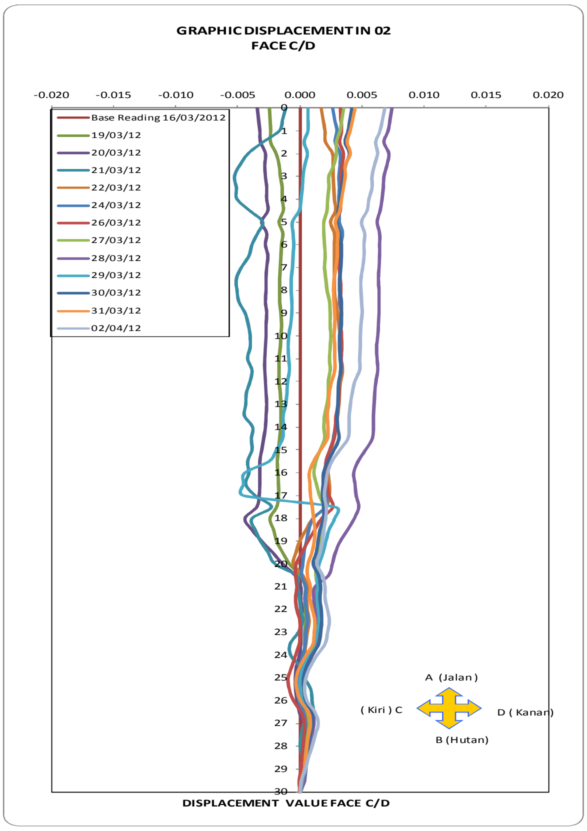


Figure 4: Layout of the Inclinometer at Pier-P1 Sta. 22+625

The results of the mesurement with five inclinometers installed shows at Figure 5.





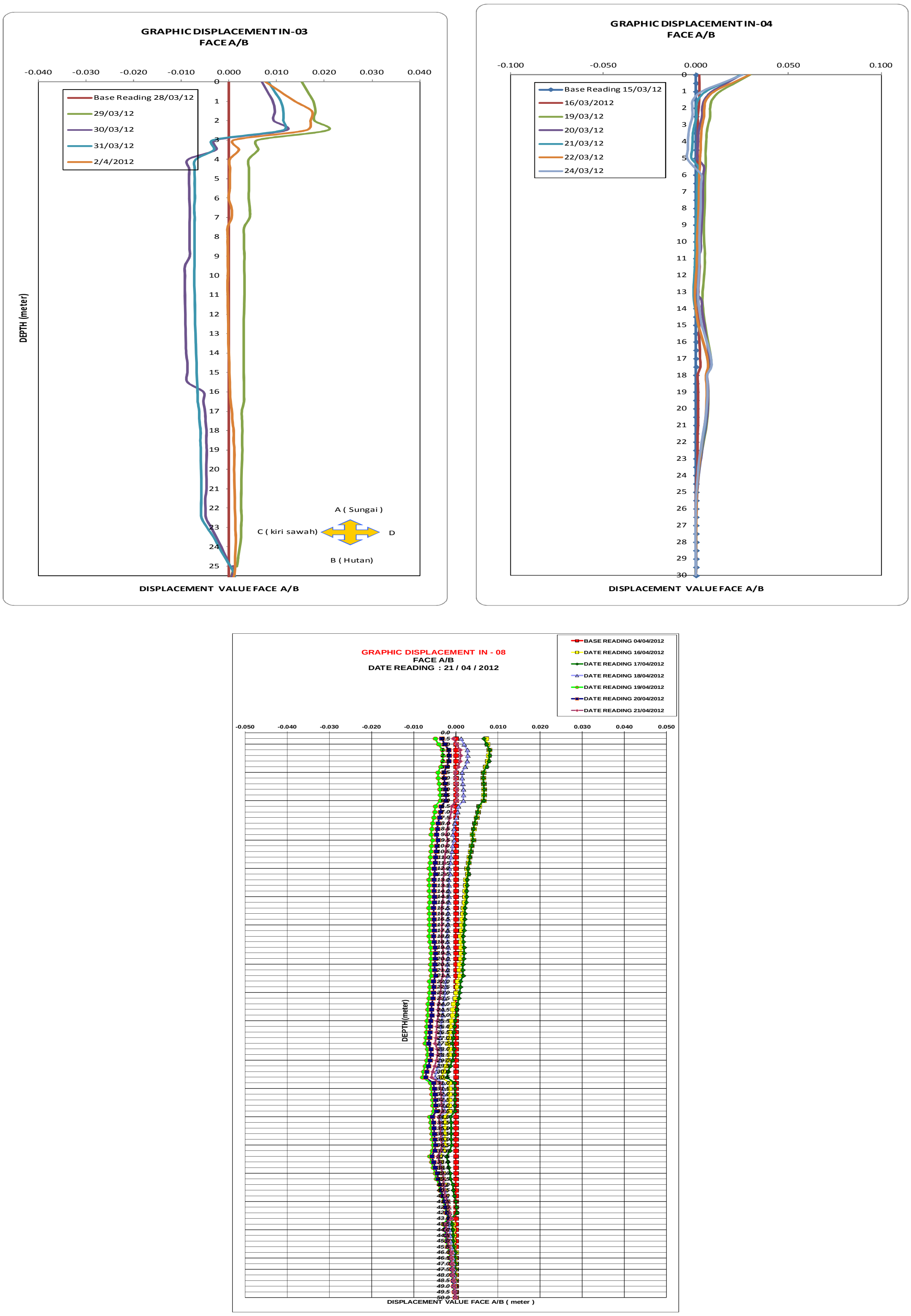


Figure 5: Results of Mesurement Inclinometers at Sta. 22+625

Figure 5 shows the results of several tools inclinometer measurement. Inclinometer number 01 indicate that there are soil mouvement from the surface land untill 28 m depth from the top surface. The value of the soil mouvement is about from 10 cm to 15 cm. Inclinometer no.02 shows the mouvement of the soil in two directions ranges from 5 – 10 cm

from the land surface to 25 m depth. Inclinometer no.3 shows the soil mouvement in two directions with ranges 20 cm from top surface to 5 m depth and the soil mouvement change direction to 10-12 cm till the end of the Inclinometer. Inclinometer no.04 address the mouvement of soil vers 1m at the top of surface and return to value of 0-5 cm displacement untill the 30 m depth. Inclinometer no. 08 shows the soil mouvement from the top vers 10 cm and decline automatically at the end. In general, the measurement of all Inclinometer shows a soil maximum mouvement at the top surface land and tends decline untill the end of the Inclinometer. Beside that, in the field, there are differences elevation approximately 25 m between the original surface land (before slipe failure happen) and after slipe failure happened.This prouves that the slip failure happened is caused by reduced shear strength of the soil significantly.

SLOPE STABILITY

Pier P-1 structure laids on the steep natural valey and stands up on clay-shale. The slip failure occured when the plat-form of Pier P-1 structure was realised. To take over this problem happened in the field and give a guarrantee succesfully bored pile foundation construction needs geotechnical engineering

Results of the investigation in the field indiquate that the slope failure was identified caused by infiltration of rain fall into to the soil and it cause reduction of shear strength of soil. From observation in the field the rain-fall water get out at the plat-form of Pier P-1 structure area. Based on that conditions and the topography existing was proposed a new slope built in four steps with 1,50 m berm width and the slope is made 1 V : 2 H. To analizys the slope stability use Plaxis program version 8.50. The parameters of soil is presented in Table 2. below.

Table 2: Soil Properties

Parameter	Symbol	Tuffa	*Clayshale*	
Weight volume unsaturated	γ_{unsat}	17,50	16,00	kN/m^3
Weight volume *saturated*	γ_{sat}	18,50	18,50	kN/m^3
Modulus elastisitas	E_{ref}	9200	9200	kN/m^2
Poisson ratio	ν	0,33	0,33	-
Cohesion	c_{ref}	64	50	kN/m^2
Frictian angle	ϕ	22	20	^{o}
Dilatance	ψ	0	0	-

Source : PT Waskita Karya, 2012

The results of the Plaxis program version 8.50 is presented in Figures 5,6,7,8,9,10 and 11 as below.

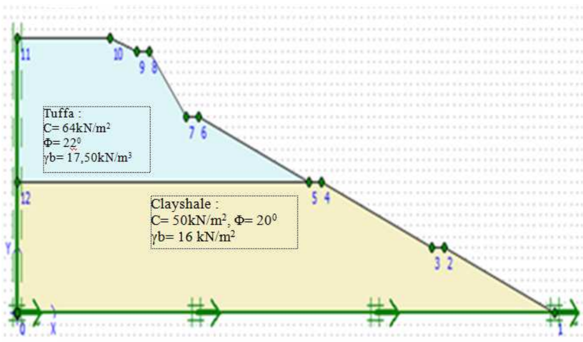


Figure 6: Topography Model of Slope Stability Analyzis Proposed

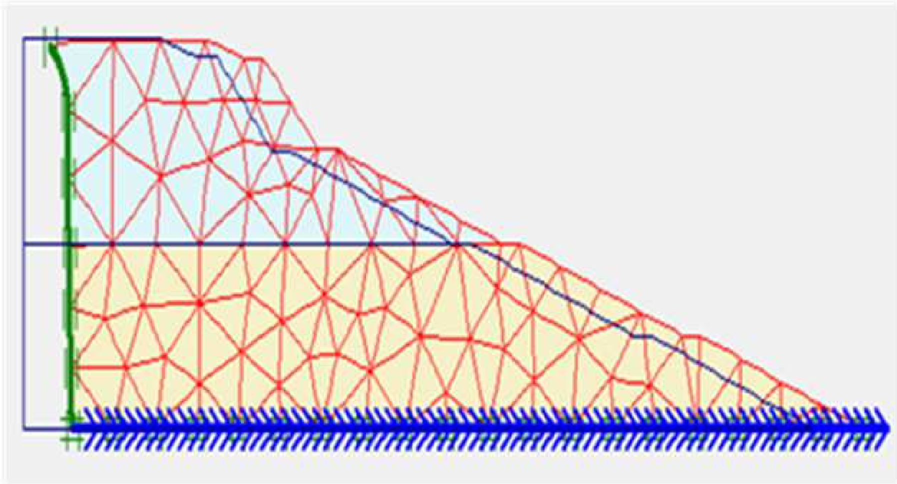


Figure 7: Deformed Mesh

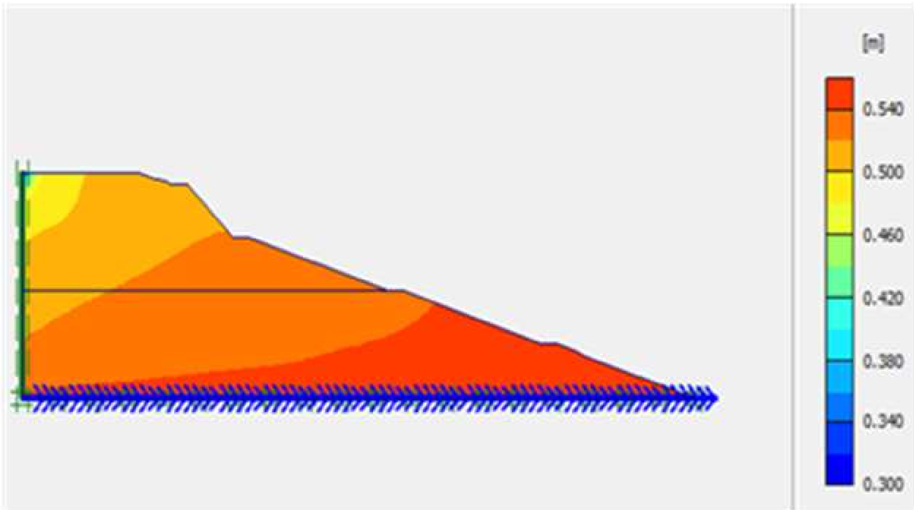


Figure 8: Total Displacements

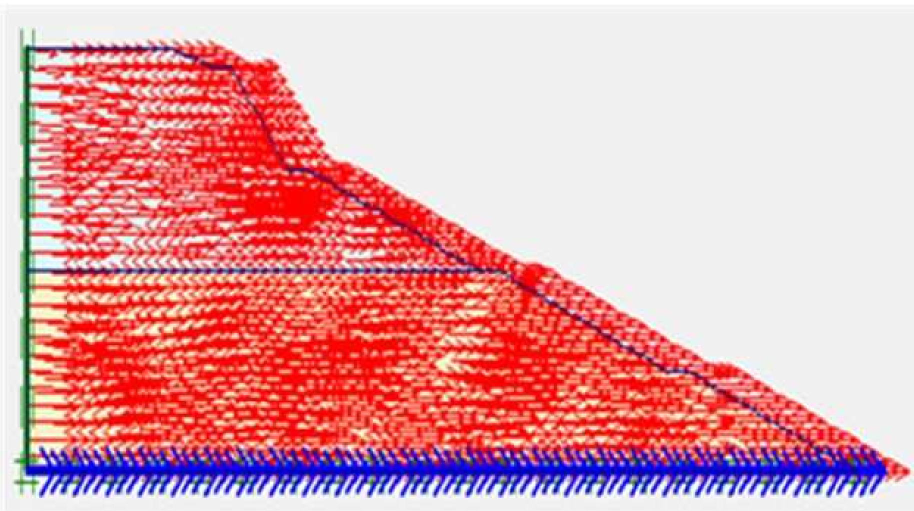


Figure 9: Direction of Soil Displacements

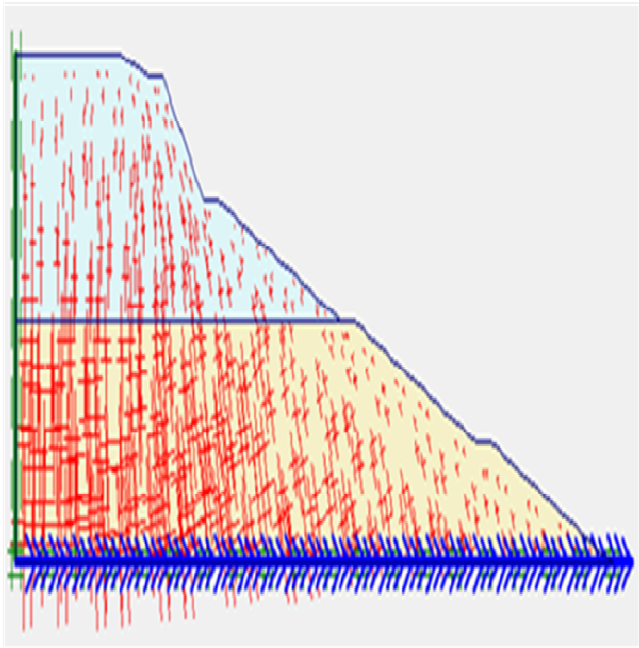


Figure 10: Effective Stress

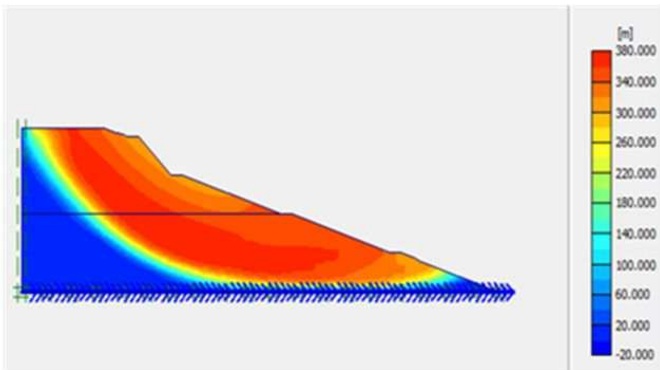


Figure 11: Maximum Potential of Slope Failure

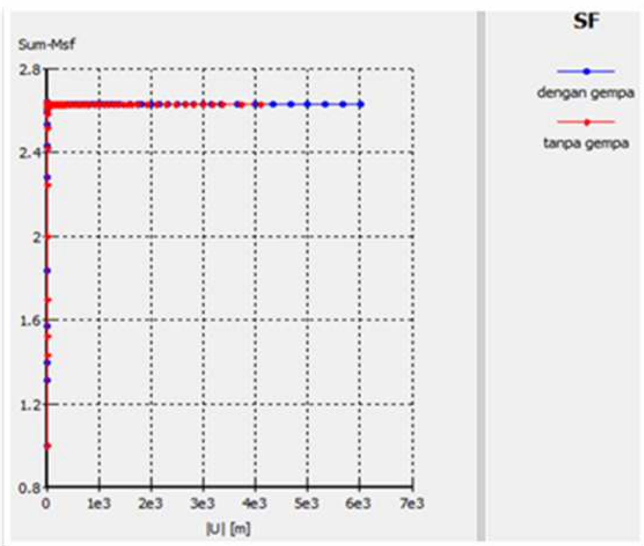


Figure 12: Safety Factors

The result of the Plaxis program shows the deformed mash in Figure 7. The Figure 8 shows total displacements $543{,}78.10^{-3}$m and the direction of soil displacements is showed in Figure 9, Maximun potential of slope failure is presented in Figure 10 and the Effective stress is -454,86 kN/m^2 presented in Figure 11. Finally, the Figure 12 shows the safety factor obtained. The safety factor is 2,60 more than 1,30 recomended in the field, so the slope is stable. From the slope stability analysis used Plaxis version 8.50 got a good solution to prevent slope failure with a new slope built in four steps with 1,50 m berm width and the slope is made 1 V : 2 H.

CONCLUSIONS

The geotechnic review is important for a civil engineering consultant, consultant supervisi and contractor to have some fundamental geotechnical knowledge to prevent failure occurs. To prevent the slope failure, a new slope should be built in four steps with 1,50 m berm width and the slope is made 1 V : 2 H is recommanded. This new slope structure can ultimately facilitate the work in the field

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REFERENCES

1. Abramson W.T. et all. (1996). *Slope Stability and Stabilization Methods*, John Wiley & Sons, Inc. New York.
2. Das B.M. (1984). *Fundamentals of Soil Dynamic*, Elservier Science Publishing Co.Inc. New York, USA.
3. Das, B.M. (1999). *Principles of Foundation Engineering 4th Edition*, Brooks/Cole Publishing Company.
4. Duncan, J.M., and Buchignani, A.L.(1975). *An Engineering Manual for Stability Studies*, Civil Engineering 270B, University of California, Barkeley, CA.
5. Paulus P. Rahardjo. (2005.). *Manual Pondasi Tiang*, Edisi- 3, GEC – Geotechnical Engineering Center, Bandung.
6. Dainty Zahrina Putri. (2013). *Analisis Stabilitas Lereng dengan Perkuatan Geotekstil Menggunakan Software Plaxis, Studi Kasus pada Lereng Sta. 2+225, Proyek Jalan Tol Semarang-Solo*, Tugas Akhir S1, Yogyakarta.
7. PT. Global Perfex Synergi & ASS. (2012.). *Justifikasi Teknik Pekerjaan Timbunan Abutment dan Badan Jalan Lokal serta Fondasi Tiang Bor pada Overpass Sta.22+125 s/d Sta. 22+840, Bawen. Semarang*, Semaran.
8. PT. Global Perfex Synergi & ASS. (2012). *Justifikasi Teknik Pekerjaan Dinding Penahan Tanah (Retainning Wall) pada Abutment A2, Sta.22+125, Bawen. Semarang*, Semarang.
9. PT. Global Perfex Synergi. (2012). *Justifikasi Teknik Fondasi Tiang Bor pada Overpass Sta.22+850*, Bawen, Semarang.
10. PT. Global Perfex Synergi. (2012). *Justifikasi Teknik Fondasi Tiang Bor pada Overpass Sta.21+800*, Bawen, Semarang.
11. PT. Selimut Bumi Adhi Cipta. (2012). *Hasil uji Laboratotium tanah Batuan, Pembangunan Jalan Tol Semarang – Bawen, Paket VI*, Semarang.

12. PT. Waskita Karya Tbk. (2011). *Laporan Soil Investigation Bor Mesin/Bor Log*, Semarang.
13. PT. Waskita Karya Tbk. (2012). *Laporan Pelaksanaan Pengeboran fondasi tiang bor*, Semarang.
14. PT. Wiecon Consultant. (2012). *Sub-structure and Superstructure for Lemah Ireng Bridge*, Final report, Semarang.
15. PT.Wirama Karya Consultant. (2004). *Pekerjaan Pembangunan Jalan Tol Semarang – Solo*, Semarang, Jawa Tengah.

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